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A TISM and MICMAC Analysis of Factors During the COVID-19 Pandemic in the Indian Apparel Supply Chain

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ABSTRACT

The main aim of this study is to explore the challenges faced by the Indian apparel supply chain in the wake of COVID-19 to identify the factors that are being affected and build a multilevel hierarchy model to prioritize the factors and understand their inter-relationships. An intensive literature review was conducted, and many experts from apparel supply chain were consulted. The study was conducted by the help of a survey sent to these experts from different echelons in the apparel industry. The data was then analysed using total interpretive structural modelling (TISM). A multi-level hierarchy TISM model and MICMAC (matrice d'impacts croisés multiplication appliquée á un classment) analysis were used to establish a relationship between the identified factors. The "difficulty in export order fulfilment" factor is found to be the most sensitive factor, which means that it is present in the TISM model hierarchy in a place that it is affected by most of the factors and in-turn impacts factors like operational cost, change in marketing strategy, change in consumer buying pattern, which impact profitability and cut-off in employment. "Cut-off in employment" is found to be most impacted by all other factors in the TISM model.

KEYWORDS

Apparel Industry, COVID-19, India, MICMAC Analysis, Operational Cost, Pandemic, Profitability, Supply Chain, Textile Industry, Total Interpretive Structural Modelling

1. INTRODUCTION

Textile industry is one of the oldest industries in Indian economy. It is a major part of India's cultural heritage. It is world's second largest producer and exporter of textiles and garments (Berwal, 2020). Because of profuse availability of fibres there is a broad scope for textile industry in India. Textile industry supplies in a plethora of fields like: Home textiles, defence, medical textiles, aero – space textiles, automotive textiles, agricultural textiles, construction, architecture, automotive shipping,

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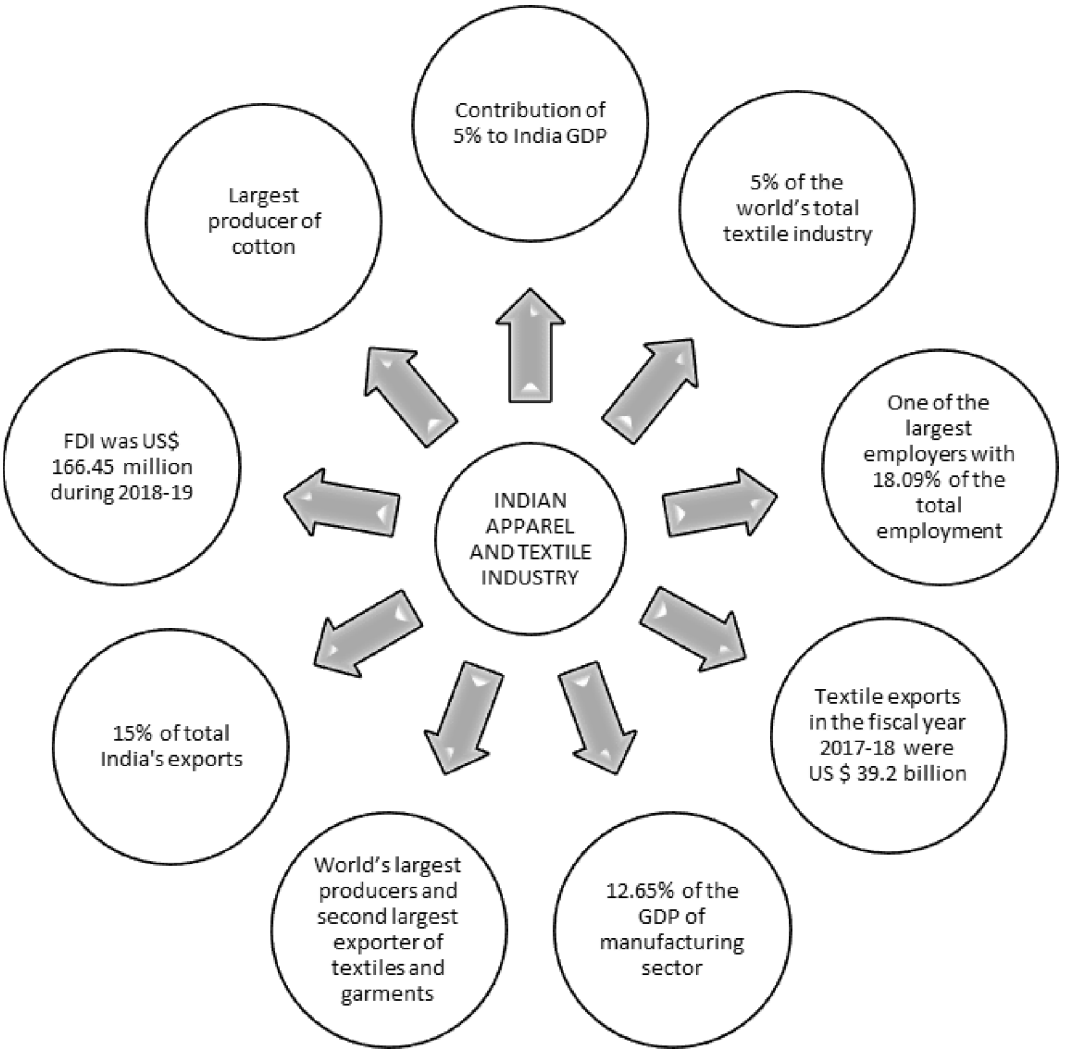
apparel, chemical, mining etc (McCarthy, 2016) (Paul, 2019).Its contribution towards socio – economic goals in India e.g., - empowerment of women by fulfilling their economic needs and giving them financial independence providing livelihood to people in every region in India (Dixit and Lal, 2019). A summary of the role of apparel and textile industry in Indian economy can be seen in Figure 1.

In a webinar conducted on "How Can Indian Textile Industry Reboot Its Business and Encash Upon Global Opportunities" (5th June 2020) an expert in Home Textiles Mr. Khandelia talks about how when countries like U.S.A. and European countries started relocating their textile industry because of high cost to India and other Asian countries, Indian Textile industry started thriving when it came to exports. As old as textile industry in India has been, the per capita consumption was very low. So, the exports really helped with the Indian economy (Vanchan, Mulhall, & Bryson, 2017). Even though compared to many countries India's trade globally is not where the India Apparel industry aspires to be. One of the reasons is the lack of broader product basket (For example – performance wear, Formal Wear, Sportswear etc.) in fashion sector affecting India's Global trade (Mukherjee & Chanda, 2016).

Figure 1. Role of Indian Apparel and Textile Industry in Indian Economy

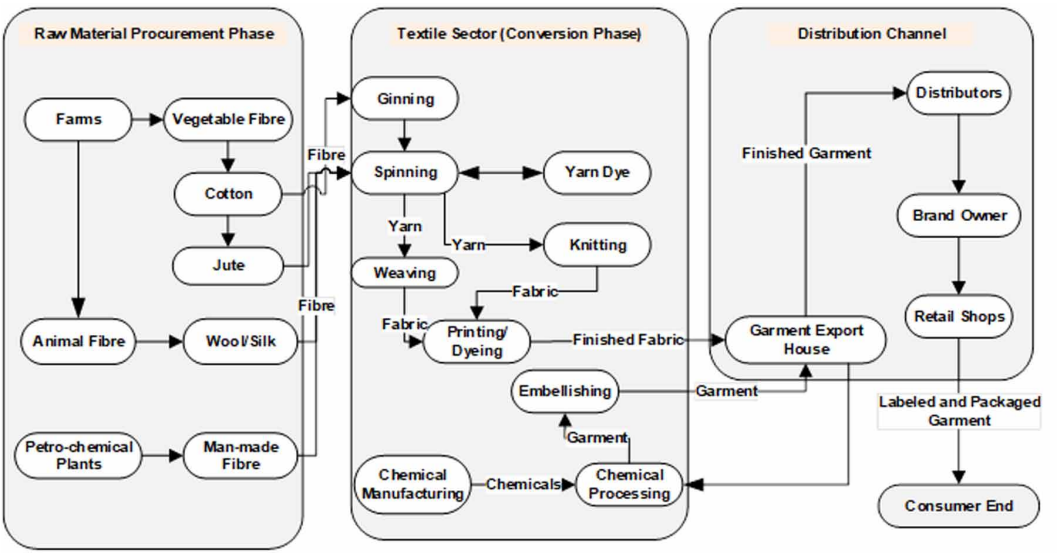


According to the (Ministry of Textiles, Govt. of India) Indian textiles and apparel industry accounts for approximately 5% of the world's total textile industry. The production of fibre, the yarn fabric and apparels, i.e., the entire supply chain gives India an advantage over other countries (Ministry of Textiles, Govt. of India).

Another growing area, that is playing a vital role in the growth of economy in textiles in India, is Technical Textiles. The growth of technical textiles is directly proportional to the economic growth of our country (McCarthy, 2016). Technical textile is a field that did not suffer the negative impacts of the pandemic as much as the other sectors. Because of their contribution in Infrastructure Sector and the production of PPE's and other protective gear for doctors in today's time technical textiles actually saw an increase in the orders. Because of these this sector is considered essential. The end use of the product in this sector defines how rigorous and efficient the procedure of production has to be. The technical minutiae have to be just right, there can be no mistake as explained by (Zhao, Jiang, & Cao, 2020).In the wake of COVID-19 crisis, throughout the world industries have been immensely affected, and thus supply chain in textile industry is also being disturbed. Purpose of this study is to identify, study and analyse the effects of COVID-19 on Indian Apparel Industry supply chain, and prioritise the problems faced during this crisis, suggest measures to deal with them.

To understand it better first we need to understand apparel supply chain. Supply chain is a crucial part of any manufacturing industry. It includes purchasing raw material from vendors, transportation of raw material to the manufacturing unit, conversion of raw material into finished goods, and then delivery of the finished goods to the consumer. Contrary to supply chain in any industry, when it comes to textile industry there is a finished product at every stage of the supply chain. The supply chain is very complex because of this very reason. Because of the wide range of areas textiles are used in there are many routes, that can be taken, depending on the product, which can be fibre, yarn, fabric or garment. Different stages in the apparel supply chain where end products are produced in the Figure 2 (developed by the author by consulting an expert in the field). Any disruptions at any stage in the supply chain causes a ripple effect of disruptions throughout the chain.

Figure 2. Indian Apparel Industry Supply



2. LITERATURE REVIEW

COVID-19, being as recent as it is, has inspired many researchers to study its various impacts on different aspects of businesses across the world. Here this section is going to focus on findings of some of the studies done by various researchers about the impact of pandemics (COVID-19) on supply chains, and economy.

Solanki (2017) emphasises on the importance of apparel and textile sector in Indian economy has been explained. Apparel and fabric sector contribute about 14% to Industrial sector, contribute about 4% to India's GDP. 15% of country's export income comes from this sector too. Firms in Apparel supply chain are the second largest employment provider, providing jobs to 51 million people directly and 68 million people indirectly (Ministry of Textiles, Govt. of India). Another important sector is technical textiles, which plays a very important role in Indian economy's growth. Dixit and Lal (2019), talk about how there are a lot of opportunities in textile sector and how the unorganised textile sector is least bothered about social responsibilities towards employees and society. However, this sector creates a massive number of jobs and is the second largest employer and it is constrained by many factors such as: unequal access to international markets, comparatively higher wage prices, restrictive labour laws obstructive productivity, inadequate incentives for investments and exports, etc. Going forward catering to these obstacles while keeping in mind welfare of staff and labour will help in getting the Indian Apparel industry to where it aspires to be internationally. Gulhane and Turukmane (2017), talk about how the Make in India initiative is beneficial for textile and apparel sector. It will lead to more job creation, boosting the national economy and give the Indian economy global recognition. A concise literature review has been shown in Table 1.

2.1. Issues Faced by Apparel Supply Chain During COVID-19

O'Leary (2020) contemplates on what questions need to be asked and researched in the time of COVID-19 in different sectors. One of the sectors the author studied was "Supply chains and different patterns of supply and demand". The problems faced during the social distancing will also be faced during production processes, which may lead to lower productivity. Industries are seeing a lot of change in demand and supply patterns too (Naeem, 2021). Many supply chains turned out to be precarious during the pandemic lockdown. The study suggests further research to be done on Supply Chain fragility, and changing patterns of supply and demand. Dixit and Lal (2019), draw attention towards various problems faced by apparel industry like - unequal access to international markets, comparatively higher wage prices, restrictive labour laws obstructive productivity, inadequate incentives for investments and exports, etc.

Dmitry Ivanov (2020) concluded that since the effects and duration of such epidemics is unpredictable, it is difficult to ascertain the precise risks pertaining to supply chain as a result of the pandemic. The longer duration of disruptions in different echelons in the supply chain causes the most negative impact on supply chains. Guerrieri *et al* (2020) – explained a result of negative supply shock companies may see deficiency in demand. Providing abundant social insurance has a positive impact in scenarios like these. Dev and Sengupta (2020) deduced that Policies need to be scaled up for faster and better response as the situation gets worse. The shock to the economy needs to be minimised so there can be a faster recovery.

Inoue and Todo (2020) observed that as the industries start facing the shortage of supply and demand, the supply chain beyond city will also face negative effects of the lockdown. It was also observed that the longer the lockdown lasts the higher negative effects it will have on companies farther along in the supply chain. The study further infers that instead of lockdowns there should be alternative measures that can be put in place at an earlier stage in case of a pandemic so that there is no need for a lockdown or it is as short as possible because of the increase in negative impacts along the supply chain.

Table 1. Literature Review

Sl. No.	Topic	Method Used	Country	Implications	Reference
1	• Sustainable supply and production • COVID-19	Review Paper	USA UK	The authors posit these areas that need to be researched on: • Return of Global supply chains and lean JIT management • Management of inventories going further	(Sarkis *et al*, 2020)
2	• Global supply chains • COVID-19	Quantitative framework, methods	UK	• Renationalisation will only help a country's economy if there are less stringent lockdown rules than its trading partners.	(Bonadio *et al*, 2020)
3	• impacts of epidemic outbreaks on global supply chains • simulation based analyses on the coronavirus outbreak	Discrete-event simulation methodology	USA China Germany Brazil	• Since the effects and duration of such epidemics is unpredictable, it is difficult to ascertain the precise risks pertaining to supply chain as a result of the pandemic. • SC simulation model can be used by decision-makers to predict the operative and long-term impacts of epidemic outbreaks on the SCs and develop pandemic SC plans.	(Ivanov, 2020)
4	• Food supply chains • COVID-19 pandemic	Review Paper	Canada	• Robust and reliable supply chain relationships are necessary to enriching supply chain resilience. • Steps to tone down stockpiling behaviour of consumers in such times need to be considered. • Policy priority - Ensuring the continued availability of essential food and non-food items to vulnerable communities	(Hobbs, 2020)
5	• Evolving Information Systems and Technology Research Issues • COVID-19 and Other Pandemics	Review Paper	USA	• supply chains of critical goods have not worked, and that many supply chains are too fragile for pandemic times. • Research is needed to investigate how to improve supply chains for example, determining other factors that lead to "supply chain fragility." • Because of lockdown there is need for virtual communication, but virtual communication and software needed for it have their own limitations.	(O'Leary, 2020)
6	• Propagation of the economic impact through supply chain • Mega city Lockdown • COVID-19	Application of agent-based model to supply chain	Japan	• Consider lockdown to be last resort, try to contain the spread of disease earlier, avoid lockdown of mega cities. • Mega city lockdown should be as short as possible if cannot be avoided.	(Inoue and Todo, 2020)
7	• Effect of Negative Supply Shockson Demand • Implications of COVID-19	Model Predictive Control (MPC)	UK	• Deficient demand is a result of supply shock. • Providing abundant social insurance can have a positive impact in scenarios like these.	(Guerrieri *et al*, 2020)
8	• Covid-19 • Impact on the Indian Economy	Review Paper	India	• Policy makers need to scale up the response so as to minimise the impact of the shock on both the formal and informal sectors. • The responses need to remain preserved in arules-based framework to avoid long-term damage to the economy.	(Dev and Sengupta, 2020)
9	• Covid-19 • World of Retailing	Review Paper		• Since even before COVID-19 consumers preferred online shopping, the increase in online retailing is going to prevail post COVID-19. • During these extenuating circumstances the cost of everything increasing has led to the increase in the price of the products, which in turn affects the consumer behaviour.	(Roggeveen & Sethuraman, 2020)
10	• Impact of Covid-19 on businesses and workers	Review Paper	India	• the corona virus is affecting sectors like tourism, aviation, hospitality and trade the most. • It will be followed by a wider impact on other sectors as economic activity stalls.	(Koshle *et al*, 2020)

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Table 1. Continued

Sl. No.	Topic	Method Used	Country	Implications	Reference
11	• Role of textile industry in Indian economy	Review Paper	India	• Low cost and skilled manpower are available which gives a lot of benefits to industry. • Looking Forward potential in growing domestic and international market.	(Solanki, 2017)
12	• Indian Textile Industry • Inclusive Growth and Social Responsibility	Review Paper	India	• Textile sector creates a massive number of jobs and is the second largest employer. • It is also constrained by many factors such as: unequal access to international markets, comparatively higher wage prices, restrictive labour laws obstructive productivity, inadequate incentives for investments and exports, etc.	(Dixit& R.C., 2019)
13	• Effect of Make in India • Indian Textile Industry	Review Paper	India	• The textile sector has the capability to contribute highest to the Indian economy by providing more jobs and contributing to the overall GDP. • It is the need of today that 'Make in India' campaign become the philosophy of the country and national movement.	(Gulhane & Turukmane, 2017)
14	• Coronavirus Pandemic • Globalization	Review Paper	USA	• Industries will start to pull back from global supply chains and concentrate more on local firms, as where the material is coming from is becoming a priority. • COVID-19 will create a world that is less open, less prosperous and less free	(O'Neil *et al*, 2020)
15	• COVID-19 • India Food Supply Chains	Review Paper	India	• People started ordering in and now it looks like consumers may not go back to the same buying habits. Delivery services may see an acceleration even post COVID-19. • Small business owners will face more problems compared to large businesses.	(Reardon *et al*, 2020)
16	• Viable supply chain model • Assimilating agility, resilience and sustainability perspectives • COVID-19 pandemic	dynamic systems theory and SC structural dynamics control approach		• The VSC model can be of value for decision-makers to design SC structures, as it is able to withstand disruptions and recover, and survivable during long-term, global disruptions with societal and economic shocks	(Ivanov, 2020)
17	• COVID-19 • Trade Policy • Global Supply Chains	Book chapter by literature review	China	• Diversification of supplier base and look at reshoring. • Opportunities will arise for less popular investment destinations to enter or to intensify participation in global value chains.	(Javorcik *et al*, 2020)
18	• Small Businesses • Coronavirus Pandemic	Qualitative Survey	USA	• Mass layoffs and closures of small businesses are already happening. • Financial stability of businesses is very low, as cash on hand is less than a month's expenses. • Different opinions about the likely duration of coronavirus pandemic. • Accessing the aid, such as bureaucratic hassles and difficulties establishing eligibility are some of the reasons why a lot of businesses that were planning to get loans from CARES act are now hesitating to get funding.	(Bartik *et al*, 2020)
19	• Supply and demand shocks • COVID-19 pandemic	Remote Labor Index	USA	• First order aggregate shock to economy represents reduction of approximately a quarter of economy. • Supply and demand are so different by sectors that even a gradual reopening will leave an imbalance between the two in industries. • Low wage occupations compared to high wage occupations are more vulnerable.	(Rio-Chanona *et al*, 2020)

Hobbs (2020) delves into the effects of COVID-19 on the Food Supply Chain in Canada. The study implies that cross border supply chains need to stay open so that the firms along the supply chain don't have to suffer as much. Panic buying and stockpiling behaviour of consumers is something that needs to be kept in mind while designing strategies for future pandemics or similar situations. During the time of pandemic Supply chain responsiveness is an important factor which will determine the degree of negative impact that the supply chain will have to bear. Koshle (2020) discussed that the major challenge businesses are facing right now is how to keep workers safe from COVID-19 while making sure the production processes are also not disrupted.

This may all be better relevant in case of large corporations, but when it comes to small businesses the risks and consequences of these situations are a lot higher. Bartik *et al* (2020) observed that small businesses have a small amount of cash with them. In a situation like this they have few options left – dramatically cut expenses, take additional debt, or declare bankruptcy. As the imports have now stopped, dependency on domestic businesses is more than ever, and if they cannot survive this crisis then it will be difficult to find new suppliers in this time.

Reardon *et al*. (2020) discuss how with the onset covid-19 pandemic world saw a rise in ecommerce affecting local supply chains. Food supply chains were no different. People started ordering in and now it looks like consumers are not going to go back to the same buying habits and delivery services may see an acceleration even post COVID-19. Small business owners may face more problems compared to large businesses. Large businesses have their own warehouses and it may help them get through the time when supply chain is hindered but small businesses rely on supply chains on a regular basis and won't be able to survive if cannot reach their suppliers. They are more exposed to the effects of pandemic in every way.

Rio-Chanona *et al* (2020) point out that supply shocks and demand shocks are very different although often talked about together. Because of that difference even if the industries are reopened gradually it still might result in unexpected inflation of some products. Low wage occupations as compared to high wage occupations are more disposed to be affected by COVID-19. It will create inequality where there is already income inequality in society. Some industries will face supply shocks and reduce their demand from other companies, resulting in decreased output, lower profit which in turn will lead to a halt in the payment of furloughed employees. This will in turn cause loss of income and further loss in demand.

2.2. Future Outlook of Industries Beyond COVID-19

Roggeveen and Sethuraman (2020), focus on "Retailing" sector of the supply chain. Study contemplates on how COVID-19 is going to change the retail process and which changes are going to remain post COVID-19. Some new consumer behaviour and new changes in retailing will be the new normal. Since even before COVID-19 consumers preferred online shopping, the increase in online retailing is probably going to prevail post COVID-19. During these extenuating circumstances the cost of everything increasing has led to the increase in the price of the products, which in turn affects the consumer behaviour. Indian Govt. has been promoting Make in India initiative to control these prices. (Gulhane & Turukmane, 2017)suggest how the Make in India initiative is beneficial for textile and apparel sector. It will lead to more job creation, boosting the national economy and give the Indian economy global recognition. "Make in India" is relevant and necessary now more than ever, to concentrate on boosting Indian apparel industries in these difficult times. A webinar was conducted on "How Can Indian Textile Industry Reboot Its Business and Encash Upon Global Opportunities", (5th June, 2020) where experts from different sectors of apparel supply chain talked about how India had to start producing many medical supplies domestically, that are needed today, instead of importing them because of cost. For e.g., Indian manufacturers started manufacturing PPE's and Face masks to lower the need to import these products and thus decreasing the cost of the products by a lot. Mr. Udeshi in this webinar talked about how pre COVID-19 India imported these PPE at around Rs.2400/ PPE. Now that Indian companies are producing them their price has reduced to Rs.500-600/PPE. Experts

also stated that companies are now requesting Govt. to allow them to export these protective gears after making sure that the domestic need is met. Another sector of Apparel Industry is the production of Textile machinery. Experts also say that till now around 60% of the machinery required in apparel industry is being imported (Békés & Harasztosi, 2020). It will have a great impact on our industry if these machineries are also built in India, thus increasing jobs, helping Indian apparel industry by providing those machines at lower prices than they used to be when imported, and overall helping Indian economy too in the process. (Ghuge, 2020) concludes that making the policies alone won't work towards the renationalisation of businesses, the Govt. needs to focus on implementation by directing the efforts towards addressing the elemental problems. Author (Javorcik, 2020) talks about the time international supply chains were disrupted at the start of COVID-19. Suddenly imports in most of the countries stopped and now the countries had to find out ways of reshoring. If all the raw material for a company was imported, that company is now closed, until there is domestic production for that raw material. O'Neil (2020) discusses how the global supply chains are going to change post COVID-19 which were already becoming controversial even before the pandemic. Industries will now start to pull back from global supply chains and concentrate more on local firms, as where the material is coming from is becoming a priority. Sarkis (2020) observed that in the time of covid-19 since the global supply chains are suffering because of the lockdowns all over the world, there will now be 'glocalization' i.e. localisation of global supply chains. Sustainable supply and production are going to be something that industries will have to pitch as their USP.

Some studies found that 'glocalization' might not be the ultimate solution to dealing with pandemic like situations in future. Bonadio *et al* (2020) surmise that some renationalization of supply chains will occur worldwide, but it was found that even though severing global supply chains had an effect on economy of the countries, larger impact was because of domestic lockdowns. Therefore, in future cutting off global supply chains will only have an effect if the domestic lockdown policies will be less stringent, otherwise there would be no progress in the context of effect on supply chains. So, there needs to be a better version of supply chains as we see today that can deal with pandemics more aptly. Ivanov (2020) posits a new notion - 'viable supply chain (VSC)'. Because of the pandemic COVID-19 supply chains are facing challenges no matter what country or industry. In a situation like this the ability to adapt in the changing environments and ability to maintain itself and survive during the redesigning of the processes because of long term impacts as a result of pandemics like COVID-19 has become a necessity not just for now, but for future. Author has named this ability of supply chain as viability and stated that agility, resilience, and sustainability are three perspectives that are covered in viability. In future when long term crisis like this arises VSC's can help industries deal with the negative impacts on supply chains (Ivanov, 2020).

When the literature was reviewed, it was observed that many other authors and researchers were concerned in studying the dimensions with respect to different environments/industries. Based on the work carried out in the past, this study finds the research gaps: This pandemic (COVID-19), that the whole world is going through right now, has led to a lot of research regarding what impact it has had on everything including businesses, economies of nations, people's health etc. While doing the literature review of different studies done on the impact of COVID-19 on industries, the researcher didn't come across any study on Impacts of COVID-19 on Apparel Supply Chain in Indian context. The present study intends to focus on the factors that impact Indian apparel Supply Chain and analyse them.

3. PROBLEM FORMULATION

This study attempts to identify the factors that apparel supply chain in India is facing in the time of COVID-19. The objectives of this study are:

- To identify key factors in Apparel Supply Chain being affected in the wake of COVID-19.

- To analyse and develop multi-level hierarchy model for the identified factors using TISM and MICMAC analysis.

After identifying the factors, the next step would be to analyse these factors using TISM and MICMAC analysis to prepare a multilevel hierarchy model to identify the interrelationships between the said factors, prioritise and identify the key factors. TISM is used to convert factors derived from literature review and expert opinions into a structured and clear model to understand the inter-relationships among the factors. This method is used by researchers worldwide to find links between various factors to better understand the order and direction by creating an organised model of the relationships (Raut et al. 2018). The TISM model developed clearly indicated the relationships between the factors. The model clearly demonstrates the direct and the indirect (i.e., transitive) links between the factors (Kamble et al. 2018). A flowchart explaining the methodology is shown in Figure 3.

3.1. Data Collection

A comprehensive literature review and talking with some experts in the apparel industry from different levels in supply chain gave a detailed insight about what challenges they are facing in these difficult times and how they are adapting to the new situations. Literature review led to the Research objectives. Two research objectives were defined. Based on review and interviews a list of 23 challenges being faced by supply chains around the world was prepared. After studying those challenges 11 different factors that were being affected in the industries were identified. The factors derived are shown in the Table 2. Meanwhile the 11 factors were then converted into a survey which was then sent to many experts who are top executives from different echelons of apparel supply chain like, chemical processing plants, weaving mills, spinning mill, fibre production, garment export house etc... The survey was to measure the effect of COVID-19 on these 11 factors in the supply chain. The responses were gathered using Likert Scale in the survey. We received 12 responses. The data collected was then analysed by using ISM methodology. The complete data analysis is explained in the next section.

3.2. Analysis using ISM Methodology

In this survey, the internal consistency of the responses and the reliability test using Cronbach's Coefficient (α) was calculated. The value of α is 0.755 and descriptive statistics are presented to rank the identified factors accordingly on the basis of mean score and standard deviation as shown in Table 3.

Figure 3. Flowchart for TISM Methodology

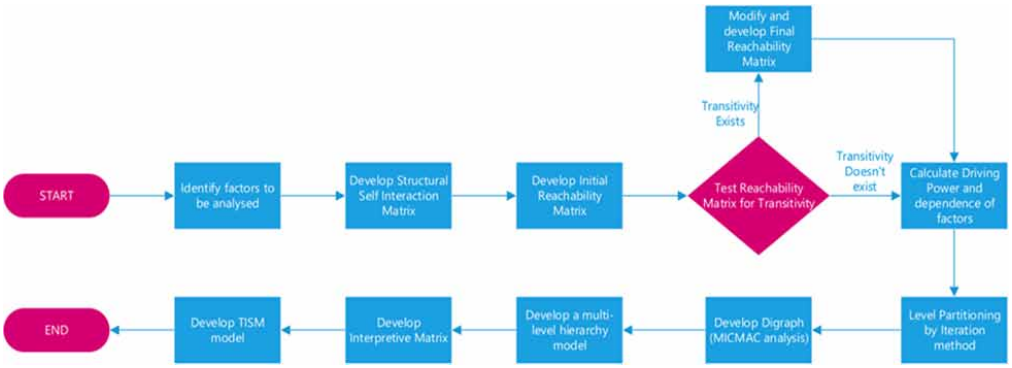

Table 2. Identification of Factors with Description

Sl. No.	Factors	Description	References
1	Cut-off in Employment	The biggest challenge our apparel industry is facing Layoffs of the workers and the employees. Even though for the top management (in different units and plants) the safety of their people was the first and foremost challenge, at a certain point layoff became necessary evil. Skilled labour and educated professionals are losing their jobs and advantages like healthcare. Factories are going to face the problem of shortage of workers as soon as they proceed to open their manufacturing plants.	(Bartik, et al., 2020) Webinar on "How can Indian Textile industry reboot its business and encash upon global opportunities", 5th June, 2020 (Karpman, Zuckerman, & Peterson, 2020) (Che, Du, & Chan, 2020)
2	Profitability	Even after relaxation in Lockdown policies for the manufacturing units the operations are not going to be like before, profits will be much less [therefore taxes paid will be much less too]. The whole industry is on the verge of recession because of Negative Supply Shock.	(Bartik, et al., 2020) (Rio-Chanona, Mealy, Pichler, Lafond, & Farmer, 2020)
3	Operational Cost	Cost saving [men, power, infrastructure, inventory etc.] is a challenge in the time of coronavirus, price of labour, transport, raw material etc. has increased. Since these depend on each other, maintaining the costs of operations in industries is difficult when options are fewer.	(Habel *et al*, 2020) Webinar on "How can Indian Textile industry reboot its business and encash upon global opportunities", 5th June, 2020
4	Variation in Product Price	Consumers are facing problems due to increased prices for the same merchandise because companies have to increase prices in these extenuating circumstances.	(Roggeveen & Sethuraman, 2020)
5	Limited cashflow in supply chain	Some buyers are either putting the contracts on hold or renegotiating contracts. New orders are taking time to come up now that everything is working at half the capacity at most. The international buyers that Indian apparel Industry deals with are facing similar financial issues as in India. Therefore, a lot of these companies have put a hold on payments to Indian Industries. A lot of money that the industries needed to survive is now out of their reach. Domestic supply chains are facing similar challenge too.	Webinar on "How can Indian Textile industry reboot its business and encash upon global opportunities", 5th June, 2020 (Bartik, et al., 2020) (Roggeveen & Sethuraman, 2020) (Inoue & Todo, 2020)
6	Increase in use of technology	Remotely controlling the activities and operations of the company became the new normal. Conducting virtual meetings for everything, and for a lot of work transition into paperless operations was required. Upgrading the digital systems so that they compatible with working from afar is now a necessity. Since none of the production work in the apparel Industry can be done from home, therefore, "Work from Home" isn't plausible in this situation. This led the entire industry including the entire supply chain to come to a halt before the industries were allowed to operate.	(O'Leary, 2020) Webinar on "How can Indian Textile industry reboot its business and encash upon global opportunities", 5th June, 2020 (Sarkis, Cohen, Dewick, & Schröder, 2020) (Javaid, et al., 2020)
7	Change in Marketing Strategy	Retailers all around the nation will face challenges attracting customers to the showrooms as the people will get accustomed to purchasing online for most of the time. High end retailers and luxurious brands will have to find a way to move business online to survive. Changing the setup of the production unit and setting the machines for production of PPE's and Face masks. This was now to be done in a very small period of time. Since the industries are now working at 30-50% capacity a change the mindset from what the procedures and routines had been from decades to new ideas on how to deal with this is required.	(Reardon, Mishra, Nuthalapati, Bellamare, & Zilberman, 2020) Webinar on "How can Indian Textile industry reboot its business and encash upon global opportunities", 5th June, 2020 (Roggeveen & Sethuraman, 2020)
8	Change in Consumer buying pattern	Ordering online has its own challenges as consumers are now facing a new dilemma i.e. where exactly the products are coming from, who is coming in direct contact with their purchased merchandise. Because of the ease of spread of virus is it safe to order the products and is the risk worth it? So even with the option of online purchase the sale is not going to be the same. Not only the production is suffering but the demand is being affected as well. There has been a diminution in demand in apparel because of many reasons, for e.g. since everybody is locked inside, they don't feel the need to buy new clothes& people losing their jobs further decreases demand as people can longer afford shopping.	(Roggeveen & Sethuraman, 2020) Webinar on "How can Indian Textile industry reboot its business and encash upon global opportunities", 5th June, 2020 (Hobbs, 2020) (Sheth, 2020)

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Table 2. Continued

Sl. No.	Factors	Description	References
9	Delivery Performance	Some units faced a different dilemma because of reverse migration of labour. They had labour for production but not for transporting the goods. Finding alternate ports for shipment became an urgency. There may be way to send the material by other ways but that will only lead to more material handling and damage. Transportation through trains is also possible in today's situation because its cheap but its very time consuming and ends up damaging the merchandise.	Webinar on "How can Indian Textile industry reboot its business and encash upon global opportunities", 5th June, 2020 (Kumar, Raut, Narwane, & Narkhede, 2020) (Silva et al., 2020)
10	Difficulty in Export Order Fulfilment	Exports have fallen because of how hard the countries have been hit by the virus. And thus, imports have fallen too. It is estimated that the Indian textiles and apparel industry is going to suffer an impact of $64 Million loss. Since in India the lockdown was placed in effect overnight, there wasn't enough time in most cases to deliver the material that was already in transit. Because the transportation came to a halt most of that material was now stuck and couldn't reach the destination.	(Bonadio, Huo, Levchenko, & Nayar, 2020) (Ivanov, 2020) (Inoue & Todo, 2020) (Kumar, Raut, Narwane, & Narkhede, 2020)
11	On time supply of raw material	A new challenge to find alternative supply chain closer to home as long-distance transportation is not affordable or in some cases feasible anymore. The whole industry is on the verge of recession because of negative supply shock. Direct supply disruptions hindering production since the disease is focused on world's manufacturing heart, East Asia, and spreading fast. Explicably the Indian apparel industry manufacturing units reached a standstill too.	(Rio-Chanona, Mealy, Pichler, Lafond, & Farmer, 2020) (Sarkis, Cohen, Dewick, & Schröder, 2020) (Kumar, Raut, Narwane, & Narkhede, 2020)

Table 3. Ranking the identified factors affecting Apparel Supply Chain

Factors	Mean Score	Ranking	Std. Deviation
F1. Cut-off in employment	2.50	11	1.190
F2. Increase in use of technology	2.67	10	1.557
F3. On-time supply of raw material	3.00	8	1.348
F4. Difficulty in export order fulfilment	3.00	9	1.595
F5. Change in consumer buying pattern	3.08	7	1.443
F6. Operational cost	3.25	6	1.138
F7. Change in marketing strategy	3.42	5	1.165
F8. Delivery performance	3.58	3	0.996
F9. Limited cash flow in supply chain	3.58	2	0.900
F10. Variation in product price	3.58	4	1.564
F11. Profitability	4.00	1	1.128

3.2.1 Developing Structural Self Interaction Matrix

The first step in TISM methodology is defining contextual relationships between the factors based on expert opinion by applying the parameters of VAXO matrix formulation. The parameters are as follows where i >j (Shibin, 2017):

V- i leads to j, but j doesn't lead to i
A- j leads to i, but i doesn't lead to j
X- both i and j lead to each other
O- i and j are not related to each other

The resultant matrix of this step is Structural Self Interaction Matrix as shown in Table 4.

3.2.2 Developing Reachability Matrix

The second step in TISM is making the reachability matrix (Sushil, 2017). The first step of making the reachability matrix is making the Initial Reachability matrix (IRM). It is done by replacing VAXO with binary numbers 1 and 0. The rules for developing the initial reachability matrix are (Attri, 2013; Kumar et al., 2013, 2014, 2015; Faisal and Talib, 2017):

V- value of (i, j) is 1 and value of (j, i) is 0
A- value of (i, j) is 0 and value of (j, i) is 1
X- value of (i, j) is 1 and value of (j, i) is also 1
O- value of (i, j) is 0 and value of (j, i) is also 0

The same rules were applied to the SSIM Table 4 and the resultant IRM is shown in Table 5.

The second step of developing reachability matrix is making Final Reachability Matrix by checking for transitivity. Transitivity checks are done to ensure the consistency of the reachability matrix (Shibin, 2017). Transitivity dictates that if a is related to b and b is related to c then a is related to c. If relation between a, b is 1, relation between b, c is also 1 and relation between a, c is 0, the relation between c, a is also 0 then only the transitivity applies, in such case the entry a, c is replaced with 1*. Applying the same rules to Table 5, the Final Reachability Matrix is developed as shown in Table 6.

The next step is to calculate the Driving power and Dependence using the Final Reachability matrix as shown in Table 7.

3.2.3 Level Partition on Reachability Matrix

The third step in TISM methodology is level partitioning of factors on reachability matrix by Iteration method. In this step different factors are divided into different levels. The procedure is to start with Level 1, where for every factor reachability set, antecedent set and intersection set are determined from the reachability matrix. The factors whose reachability set and the intersection set are same, occupy the level 1. For level 2 the factors occupying level 1 are removed, and the same procedure is

Table 4. Pair-wise relationship of the factors (Structural Self Interaction Matrix)

Factors	F11	F10	F9	F8	F7	F6	F5	F4	F3	F2	F1
F1. Cut-off in employment	A	O	A	O	O	A	A	O	O	A	
F2. Increase in use of technology	O	O	A	O	V	V	V	O	O		
F3. On-time supply of raw material	V	V	V	O	O	V	O	V			
F4. Difficulty in export order fulfilment	V	A	X	A	V	X	O				
F5. Change in consumer buying pattern	V	A	O	A	X	O					
F6. Operational cost	V	A	O	O	O						
F7. Change in marketing strategy	V	A	A	O							
F8. Delivery performance	V	V	O								
F9. Limited cash flow in supply chain	V	X									
F10. Variation in product price	V										
F11. Profitability											

Source: TISM Analysis

Table 5. Initial Reachability Matrix of the factors

Factors	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11
F1. Cut-off in employment	1	0	0	0	0	0	0	0	0	0	0
F2. Increase in use of technology	1	1	0	0	1	1	1	0	0	0	0
F3. On-time supply of raw material	0	0	1	1	0	1	0	0	1	1	1
F4. Difficulty in export order fulfilment	0	0	0	1	0	1	1	0	0	0	1
F5. Change in consumer buying pattern	1	0	0	0	1	0	1	0	0	0	1
F6. Operational cost	1	0	0	1	0	1	0	0	0	0	1
F7. Change in marketing strategy	0	0	0	0	1	0	1	0	0	0	1
F8. Delivery performance	0	0	0	1	1	0	0	1	0	1	1
F9. Limited cash flow in supply chain	1	1	0	1	0	0	1	0	1	1	1
F10. Variation in product price	0	0	0	1	1	1	1	0	1	1	1
F11. Profitability	1	0	0	0	0	0	0	0	0	0	1

Source: TISM Analysis

Table 6. Final Reachability Matrix of the factors

Factors	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11
F1. Cut-off in employment	1	0	0	0	0	0	0	0	0	0	0
F2. Increase in use of technology	1	1	0	1*	1	1	1	0	0	0	1*
F3. On-time supply of raw material	1*	0	1	1	1*	1	1*	0	1	1	1
F4. Difficulty in export order fulfilment	1*	0	0	1	1*	1	1	0	0	0	1
F5. Change in consumer buying pattern	1	0	0	0	1	0	1	0	0	0	1
F6. Operational cost	1	0	0	1	0	1	1*	0	0	0	1
F7. Change in marketing strategy	1*	0	0	0	1	0	1	0	0	0	1
F8. Delivery performance	1*	0	0	1	1	1*	1*	1	1*	1	1
F9. Limited cash flow in supply chain	1	1	0	1	1*	1*	1	0	1	1	1
F10. Variation in product price	1*	0	0	1	1	1	1	0	1	1	1
F11. Profitability	1	0	0	0	0	0	0	0	0	0	1

Source: TISM Analysis

done with the remaining factors to find out which factors occupy level 2 and so on. It is continued until no factors are left to occupy a new level. The level partitioning of factors of this study is shown in Table 8.

The identified factors are partitioned into six levels as obtained from the result (Table 8):

L1 = {F1}; L2 = {F11}; L3 = {F5, F7}; L4 = {F4, F6}; L5 = {F2};
L6 = {F9, F10}; L7 = {F3, F8}

3.2.4 Developing Digraph

Digraph is prepared from the reachability matrix keeping dependence on x-axis and driving power on y-axis. Depending on the values of both for a particular factor, the factor is indicated in the

Table 7. Driving Power and Dependence Calculation using Transitivity

Factors	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	Driving Power
F1. Cut-off in employment	1	0	0	0	0	0	0	0	0	0	0	**1**
F2. Increase in use of technology	1	1	0	1*	1	1	1	0	0	0	1*	**7**
F3. On-time supply of raw material	1*	0	1	1	1*	1	1*	0	1	1	1	**9**
F4. Difficulty in export order fulfilment	1*	0	0	1	1*	1	1	0	0	0	1	**6**
F5. Change in consumer buying pattern	1	0	0	0	1	0	1	0	0	0	1	**4**
F6. Operational cost	1	0	0	1	0	1	1*	0	0	0	1	**5**
F7. Change in marketing strategy	1*	0	0	0	1	0	1	0	0	0	1	**5**
F8. Delivery performance	1*	0	0	1	1	1*	1*	1	1*	1	1	**9**
F9. Limited cash flow in supply chain	1	1	0	1	1*	1*	1	0	1	1	1	**9**
F10. Variation in product price	1*	0	0	1	1	1	1	0	1	1	1	**8**
F11. Profitability	1	0	0	0	0	0	0	0	0	0	1	**2**
Dependence	**11**	**2**	**1**	**7**	**8**	**7**	**9**	**1**	**4**	**4**	**10**	

Source: TISM Analysis

respective place. For example, for F1 dependence is 11 and Driving power is 1, so, the factor F1 is indicated accordingly on the digraph as shown in Figure 4 (Kumar et al., 2013; Nath et al., 2013, 2014; Ahmad, 2019).

Autonomous Factors- none
Dependent Factors- F1, F5, F6, F7, F11
Linkage Factors- F4
Independent Factors- F2, F3, F8, F9, F10

3.2.5 Developing TISM model of Factors

The multi hierarchy model is prepared with the help of the result of level partitioning by Iteration method. The resultant model is shown in Figure 5:

L1 = {F1}; L2 = {F11}; L3 = {F5, F7}; L4 = {F4, F6}; L5 = {F2};
L6 = {F9, F10}; L7 = {F3, F8}

For preparing the TISM model the next step is to prepare Interpretive matrix by using Final Reachability matrix. It is done by interpreting the relations between the factors in ISM model and interpreting transitive relations with 1* in reachability matrix (Kumar et al., 2014; Jena, 2017; Mohseni et al., 2019). These interpretations are then placed in respective cells in the Interpretive Matrix. The same is shown in Table 9. The relations among factors shown in the interpretive matrix are then represented in the model in Figure 4 to attain the final TISM Model as shown in Figure 6. The direct links between the factors are shown with solid lines, and the transitive links are shown with dotted lines. The interpretations of the relations are depicted beside the arrow between the said factors.

Table 8. Iteration Method for partitioning the levels

Level	Factors	Reachability Set (R)	Antecedent set (C)	Intersection set (R∩C)
I	F1	F1	F1, F2, F3, F4, F5, F6, F7, F8, F9, F10, F11	F1
	F2	F1, F2, F4, F5, F6, F7, F11	F2, F9	F2
	F3	F1, F3, F4, F5, F6, F7, F9, F10, F11	F3	F3
	F4	F1, F4, F5, F6, F7, F11	F2, F3, F4, F6, F7, F8, F9, F10	F4, F6, F7
	F5	F1, F5, F7, F11	F2, F3, F4, F5, F7, F8, F9, F10	F5, F7
	F6	F1, F4, F6, F7, F11	F2, F3, F4, F6, F8, F9, F10	F4, F6,
	F7	F1, F5, F7, F11	F2, F3, F4, F5, F6, F7, F8, F9, F10	F5, F7
	F8	F1, F4, F5, F6, F7, F8, F9, F10, F11	F8	F8
	F9	F1, F2, F4, F5, F6, F7, F9, F10, F11	F3, F8, F9, F10	F9, F10
	F10	F1, F4, F5, F6, F7, F9, F10, F11	F3, F8, F9, F10	F9, F10
	F11	F1, F11	F2, F3, F4, F5, F6, F7, F8, F9, F10, F11	F11
II	F2	F2, F4, F5, F6, F7, F11	F2, F9	F2
	F3	F3, F4, F5, F6, F7, F9, F10, F11	F3	F3
	F4	F4, F5, F6, F7, F11	F2, F3, F4, F6, F7, F8, F9, F10	F4, F6, F7
	F5	F5, F7, F11	F2, F3, F4, F5, F7, F8, F9, F10	F5, F7
	F6	F4, F6, F7, F11	F2, F3, F4, F6, F8, F9, F10	F4, F6,
	F7	F5, F7, F11	F2, F3, F4, F5, F6, F7, F8, F9, F10	F5, F7
	F8	F4, F5, F6, F7, F8, F9, F10, F11	F8	F8
	F9	F2, F4, F5, F6, F7, F9, F10, F11	F3, F8, F9, F10	F9, F10
	F10	F4, F5, F6, F7, F9, F10, F11	F3, F8, F9, F10	F9, F10
	F11	**F11**	**F2, F3, F4, F5, F6, F7, F8, F9, F10, F11**	**F11**
III	F2	F2, F4, F5, F6, F7	F2, F9	F2
	F3	F3, F4, F5, F6, F7, F9, F10	F3	F3
	F4	F4, F5, F6, F7	F2, F3, F4, F6, F7, F8, F9, F10	F4, F6, F7
	F5	**F5, F7**	**F2, F3, F4, F5, F7, F8, F9, F10**	**F5, F7**
	F6	F4, F6, F7	F2, F3, F4, F6, F8, F9, F10	F4, F6,
	F7	**F5, F7**	**F2, F3, F4, F5, F6, F7, F8, F9, F10**	**F5, F7**
	F8	F4, F5, F6, F7, F8, F9, F10	F8	F8
	F9	F2, F4, F5, F6, F7, F9, F10	F3, F8, F9, F10	F9, F10
	F10	F4, F5, F6, F7, F9, F10	F3, F8, F9, F10	F9, F10
IV	F2	F2, F4, F6	F2, F9	F2
	F3	F3, F4, F6, F9, F10	F3	F3
	F4	**F4, F6**	**F2, F3, F4, F6, F8, F9, F10**	**F4, F6**
	F6	**F4, F6**	**F2, F3, F4, F6, F8, F9, F10**	**F4, F6,**
	F8	F4, F6, F8, F9, F10	F8	F8
	F9	F2, F4, F6, F9, F10	F3, F8, F9, F10	F9, F10
	F10	F4, F6, F9, F10	F3, F8, F9, F10	F9, F10

continued on following page

Table 8. Continued

Level	Factors	Reachability Set (R)	Antecedent set (C)	Intersection set (R∩C)
V	**F2**	**F2**	**F2, F9**	**F2**
	F3	F3, F9, F10	F3	F3
	F8	F8, F9, F10	F8	F8
	F9	F2, F9, F10	F3, F8, F9, F10	F9, F10
	F10	F9, F10	F3, F8, F9, F10	F9, F10
VI	F3	F3, F9, F10	F3	F3
	F8	F8, F9, F10	F8	F8
	F9	**F9, F10**	**F3, F8, F9, F10**	**F9, F10**
	F10	**F9, F10**	**F3, F8, F9, F10**	**F9, F10**
VII	**F3**	**F3**	**F3**	**F3**
	F8	**F8**	**F8**	**F8**

Source: TISM Analysis

Figure 4. Digraph Formation with four bunches (MICMAC Analysis). Source: TISM Analysis.

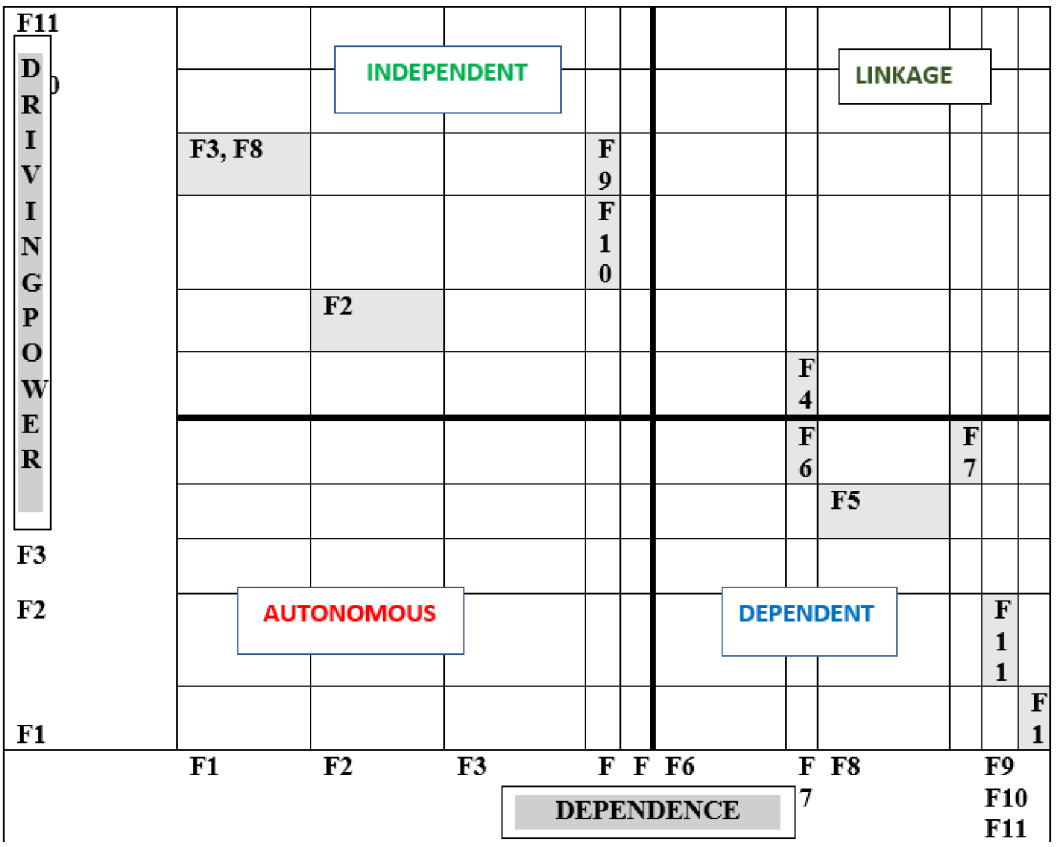
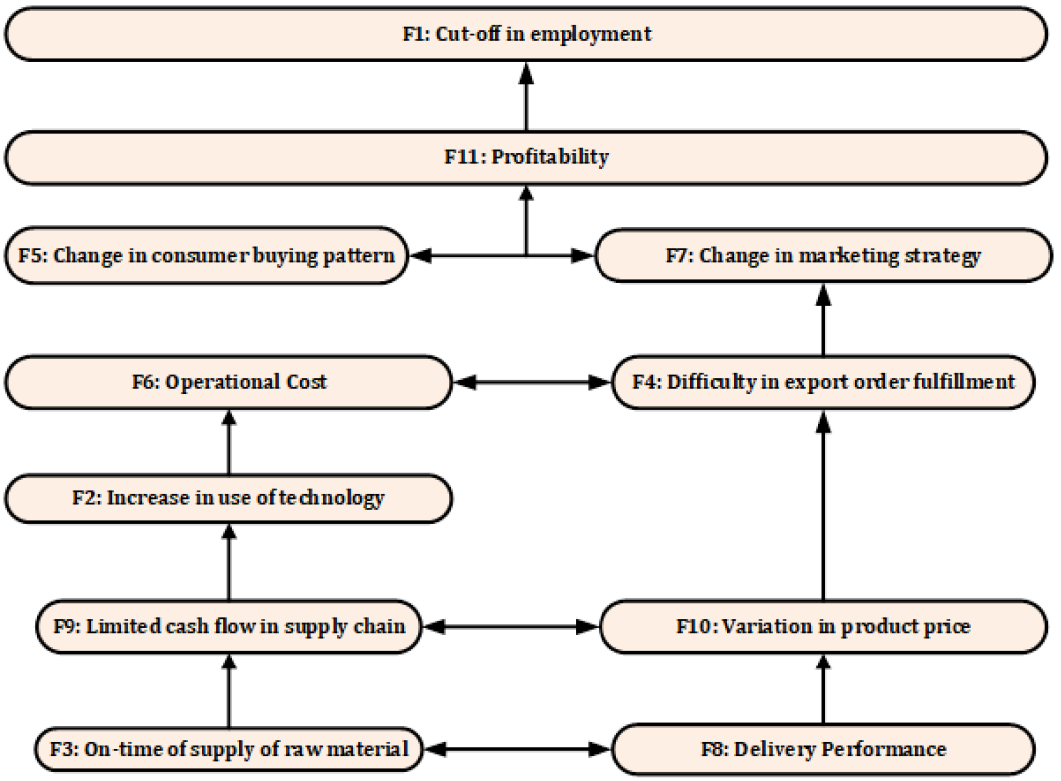


Figure 5. Multilevel hierarchy ISM Based Model. Source: TISM Analysis.



4. RESULTS AND DISCUSSION

This study has attempted to identify and analyse the key factors that are affecting the Apparel Supply Chain in the wake of COVID-19. The first step was to conduct an in-depth literature review, to better understand the apparel supply chain in India, the role of apparel industry in Indian economy, and why it is important to understand the effects of a pandemic on the Apparel supply chain. The 11 factors that were identified were, F1- cut off in employment, F2- increase in the use of technology, F3- On-time supply of raw material, F4- Difficulty in export order fulfilment, F5- change in consumer buying pattern, F6- Operational cost, F7- change in marketing strategy, F8- Delivery performance, F9- Limited cash flow in supply chain, F10- variation in product price, F11- profitability. A Likert scale survey was conducted to collect the data. TISM model was used to analyse the data (Figure 5). The model shows the complex relationships between factors, direct and transitive, and evidently shows the key factors affecting Apparel Supply Chain.

It can be seen that factor Cut off in employment (F1) holds the topmost level of the model, and Profitability (F11) holds the second level. These two factors have high dependence, thus are impacted by any impact on the rest of the factors. The last level of the model is held by On-time Supply of raw material (F3) and Delivery performance (F8). They hold the same level in the model which shows the direct impact these two factors have on the Apparel Supply Chain. The MICMAC analysis (Figure 3) also shows the high driving power of these two factors, which means the effect on these is very crucial to increase or decrease in profitability and managing workforce in the supply chain. The factor Difficulty in export order fulfilment (F4) is a Linkage factor, as can be seen in the MICMAC analysis. Linkage factors have high driving power and dependence. It means they are

Table 9. Interpretive Matrix

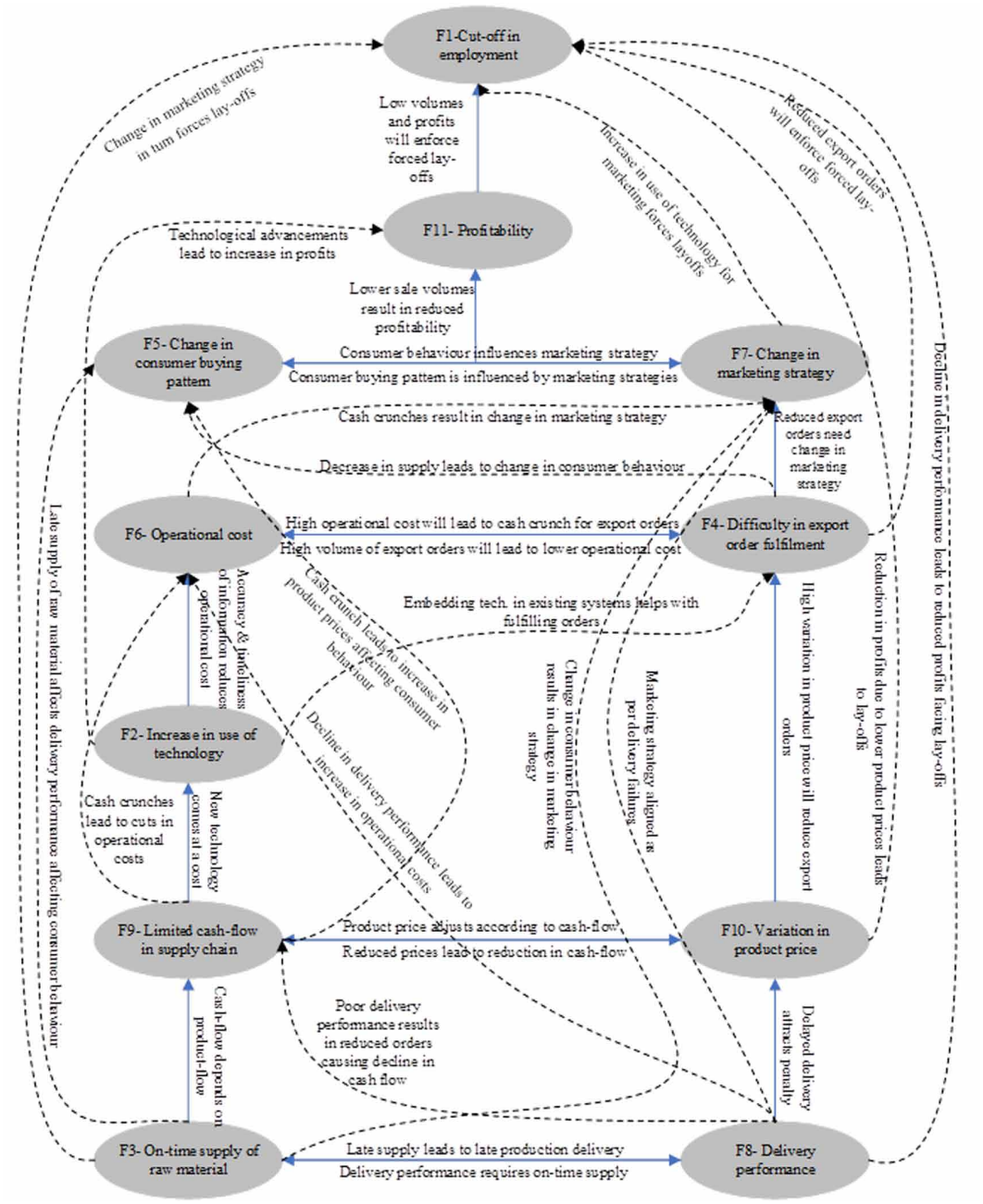
	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11
F1											
F2				*Embedding technology in existing systems helps with fulfilling orders		**Accuracy and timeliness of information reduces operational cost**					*technological advancements lead to increase in profits
F3	*change in marketing strategy in turn forces layoffs				* late supply of raw material affects delivery performance affecting consumer behaviour		*change in consumer behaviour results in change in marketing strategy	Late supply leads to delayed production and delivery	Cash-flow depends on product-flow		
F4	*reduced export orders will enforce forced layoffs				*decrease in supply leads to change in consumer behaviour	**High volume of export orders will lead to lower operational cost**	Reduced export orders need change in marketing strategy				
F5							Consumer behaviour influences marketing strategy				Lower sales volumes result in reduced profitability
F6				High operation cost will lead to cash crunch for export order			*Cash crunch result in change in marketing strategy				
F7	*increase in use of technology for marketing forces layoffs				Consumer buying pattern is influenced by change in marketing strategy						Lower sales volumes result in reduced profitability
F8	*deterioration in delivery performance leads to reduced profits forcing layoff		Delivery performance requires on-time supply			***reduction in delivery performance leads to increase in operational costs**	*marketing strategy aligned as per delivery failures		*poor delivery performance results in reduced orders causing decline in cash flow	Delayed delivery attracts penalty	
F9		New technology comes at a cost			*cash crunch leads to increase in product prices affecting consumer behaviour	***cash crunches result in forced cuts in operational costs**				Product price adjusts according to cash flow	
F10	*reduction in profits due to lower product prices leads to layoffs			High variation in product price					Reduced prices lead to reduction in cash-flow		
F11	Low volumes and profits will enforce forced layoffs										

Source: TISM Analysis

very sensitive factors (Kumar et al., 2015; Nath et al., 2014; Shibin, 2017). Any effect on the supply chain or on the rest of the factors will affect F4. Factors (F6) Operational Cost and (F4) occupy the same level, which shows the direct impact these factors will face as a result of any impact on the rest of the factors. The MICMAC analysis shows there are no autonomous factors, so all the factors are relevant to the supply chain.

The factors Increase in use of technology (F2), Limited Cash Flow in supply chain (F9) and Variation in product price (F10) fall under the Independent category in the MICMAC analysis, which means they have low dependence but high driving power. Any impact on these factors will

Figure 6. The Final TISM Model of the Factors. Source: TISM Analysis.



impact the Apparel supply chain. F9 and F10 occupy the same level (L6), and are inter-related, which means they impact each other. Factors (F5) change in consumer buying pattern and (F7) change in marketing strategy both occupy same level L3 in the TISM model and impact each other. According to MICMAC analysis, these both are dependent factors. They have high dependence and low driving power. Which means they impact the first and second level factors but are mostly dependent on the rest of the factors of supply chain. Any impact on the other factors will impact these factors as well.

5. MANAGERIAL IMPLICATIONS OF STUDY

From this study it can be clearly understood that managers from different echelons of apparel supply chain can monitor the factors that have high dependence and high driving power, i.e., the linkage factor – "difficulty in export order fulfilment", as it is the most sensitive factor. Concentration on controlling the factors that affect this needs to be the priority as it affects profitability and ultimately the layoffs. The inter-relationships among these factors in TISM model can be used to apply effective supply chain procedures (Mor et al. 2018; Kumar, 2020) and identify what factors to focus on in case of COVID-19, other pandemics, or any other similar circumstances in the future. Efforts can be made so that there is less impact on labour employment, which is the most impacted factor of all. The labour that has migrated from other parts of India to work in these industries has suffered the most during these trying times. This study can guide the managers on what areas to concentrate upon to reduce the layoffs or avoid it in future.

6. LIMITATIONS AND FUTURE SCOPE OF STUDY

The limitations of this study is that the research could only be done in India. Due to travel bans all the data was collected through telephonic conversations or emails. Experts could not be contacted face to face. As a result, the data may be expert's opinion rather than an actual representation of the situation.

This study concentrates on Industries in India; similar research could be done in other countries and the results could be compared to find out the differences in factors and their inter-relationships. Secondly, this study focuses on apparel supply chain, similar study could be done for other industries to analyse the effects of COVID-19 on their supply chain. And finally, this study specifically focuses on COVID-19 pandemic, this can be used as basis for further research on how to prepare supply chains accordingly so that they don't suffer with similar problems in future if and when such situations (any natural disaster) arise again.

7. CONCLUSION

The purpose of this study was to identify the Apparel Industry Supply Chain factors which are being affected due to COVID-19. After a detailed literature review authors found that there were a lot of qualitative research regarding what impact it has had on everything including businesses, economies of nations, people's health etc. While doing the literature review of different studies done on the impact of COVID-19 on industries, the researcher didn't come across any quantitative study on Impacts of COVID-19 on Apparel Supply Chain in Indian context. The present study's contribution is that it intends to focus on the factors that impact Indian apparel Supply Chain and analyse them using TISM methodology to find the inter-relationships between these factors, so the unique result is a well defined and clear TISM model representing the links between all the established factors in the study.

The key factors which are being impacted the most have been identified. A total of 11 factors have been identified. TISM has been used to convert factors derived from literature review and expert opinions into a structured and clear model to understand the inter-relationships among the factors. This method is used by researchers worldwide to find links between various factors to better understand the order and direction by creating an organised model of the relationships (Raut et al. 2018). The TISM model developed clearly indicated the relationships between the factors. The model clearly demonstrates the direct and the indirect (i.e., transitive) links between the factors (Kamble et al. 2018). Cut-off in employment is the factor that is placed at the highest level in hierarchy of TISM model, as it is impacted by most of the other factors. The factor directly impacting the layoffs is profitability. The more negative the impact on profitability of any organisation the more layoffs may become necessary for survival of the organisation. The cut-off in employment is inversely proportional to profitability. The less the profitability the more the chances of layoffs. Then there are

some transitive links, which are not obvious on the face of it but are indirectly affecting the factors. One such transitive link in the TISM model is change in the marketing strategy leading to layoffs. This may not seem related but indirectly change in marketing strategies in today's situation like increase in use of technology for marketing and necessity of people staying at their homes will lead to layoffs in the marketing sector. Increase in use of technology, Limited cash-flow in supply chain, variation in product price, On-time supply of raw material and Delivery performance are basic factors of apparel supply chain that are affected due to pandemic. These factors impact the other factors that are higher up in the hierarchy of the model namely Operational cost and Difficulty in export order fulfilment. The factor Difficulty in export order fulfilment is a linkage factor which means that it is present in the TISM model hierarchy in a place that it is affected by most of the factors mentioned before and in-turn impacts factors like operational cost, change in marketing strategy, change in consumer buying pattern, which impact Profitability.

In order to understand the opinions leading to the survey responses, the experts (who participated in the survey) of different echelons of the apparel supply chain were consulted. This was done to better understand what changes need to happen specifically in Indian organisations throughout the supply chain so that the Indian industry can recuperate a little faster and how this could be dealt with better in the future similar circumstances. The survey responses were based on the following suggested changes in the Indian apparel supply chains:

- Perpetual engagement and building confidence with the customer on quality, delivery on time and reliability of products.
- Indian apparel industry will now have new opportunities of business around the world. To attract more business the industry will need to pitch our own Unique Selling Propositions (USPs), i.e., sustainability. Sustainability of products, processes and factories.
- Approach of the production houses needs to be both Customer and Consumer centric.
- Generate demand and increase export by widening product base.
- Strengthening research and development centre.
- Better marketing skills are needed to create own brand and deliver according to international standards.
- Start the practice of lean inventory.
- Increasing automation for future so that there is less dependency on labour and working remotely is possible.
- The present leadership has been the decision-making power for a long time. A new generation of leadership is required. Young people need to be placed in leadership roles.
- Producers need to concentrate more on how to increase the productivity, in a time when buyers control every aspect of the production companies.
- Increase the scale of production and simultaneously focus on smaller orders.
- Allow the export of Protective gear for doctors after making sure the domestic need is met.
- Around 60% of textile machinery is imported in India. Increase the production of machinery in India.
- Giving Indian industry preference over foreign industry by the Indian Government.

REFERENCES

Békés, G., & Harasztosi, P. (2020). Machine imports, technology adoption, and local spillovers. *Review of World Economics*.

Ahmad, M., Tang, X.-W., Qiu, J. N., & Ahmad, F. (2019). *Interpretive Structural Modeling and MICMAC Analysis for Identifying and Benchmarking Significant Factors of Seismic Soil Liquefaction*. Applied Sciences.

Attri, R., Dev, N., & Sharma, V. (2013). *Interpretive Structural Modelling (ISM) approach: An Overview*. Research Journal of Management Sciences.

Bartik, A. W., Bertrand, M., Cullen, Z. B., Glaeser, E. L., Luca, M., & Stanton, C. T. (2020). *How are small businesses adjusting to COVID-19? Early evidence from a survey.* National Bureau of Economic Research, Working Paper 26989.

Berwal, R. (2020). Global aspect of Indian textile industry and their challenges and opportunities: A review. *International Journal of Home Science*.

Bonadio, B., Huo, Z., Levchenko, A., & Nayar, N. (2020). *Global supply chains in the pandemic.* NBER Working Paper No. 27224, JEL No. F41, F44.

Che, L., Du, H., & Chan, K. W. (2020). Unequal pain: A sketch of the impact of the Covid-19 pandemic on migrants' employment in China. *Eurasian Geography and Economics*, *61*(4-5), 17. doi:10.1080/15387216.2020.1791726

Dev, S. M., & Sengupta, R. (2020). *Covid-19: Impact on the Indian Economy.* Indira Gandhi Institute of Development Research, Mumbai Working Papers 2020-013.

Dixit, P., & Lal, R. (2019). A critical analysis of Indian textile industry: An insight into inclusive growth and social responsibility. *RJOAS, 4*(88).

Dixit, P., & Lal, R. C. (2019). Inclusive Growth & Social Responsibility - A Critical Analysis of Indian Textile Industry. *MERC Global's International Journal of Management*, 9.

Faisal, M.N., & Talib, F. (2017). Building ambidextrous supply chains in SMEs: How to tackle the barriers? *International Journal of Information Systems and Supply Chain Management, 10*(4), 80-100.

Ghuge, N. R. (2020). *A Study of Impact of Make in India Campaign on the Indian Economy*. SSRG International Journal of Economics and Management Studies.

Guerrieri, V., Lorenzoni, G., Straub, L., & Werning, I. (2020). *Macroeconomic implications of COVID-19: Can negative supply shocks cause demand shortages?* NBER Working Paper Series, Working Paper 26918.

Gulhane, S., & Turukmane, R. (2017). Effect of Make in India on Textile Sector. *Journal of Textile Engineering & Fashion Technology, 3*(1).

Habel, J., Jarotschkin, V., Schmitz, B., Eggert, A., & Plötner, O. (2020). Industrial buying during the coronavirus pandemic: A cross-cultural study. *Industrial Marketing Management*, *88*, 195–205. doi:10.1016/j.indmarman.2020.05.015

Hobbs, J. E. (2020). Food supply chains during the COVID-19 pandemic. *Canadian Journal of Agricultural Economics*, *2020*, 1–6.

InoueH.TodoY. (2020). The propagation of the economic impact through supply chains: The case of a mega-city lockdown against the spread of COVID-19. SSRN. 10.2139/ssrn.3564898

Ivanov, D. (2020). Predicting the impacts of epidemic outbreaks on global supply chains: A simulation based analyses on the coronavirus outbreak (COVID-19/SARS-COV-2) case. *Transportation Research* .

Ivanov, D. (2020). Viable supply chain model: Integrating agility, resilience and sustainability perspectives—lessons from and thinking beyond the COVID-19 pandemic. *Annals of Operations Research*. Advance online publication. doi:10.1007/s10479-020-03640-6 PMID:32836614

Javaid, M., Haleem, A., Vaishya, R., Bahl, S., Suman, R., & Vaish, A. (2020). *Industry 4.0 technologies and their applications infighting COVID-19 pandemic*. Elsevier.

Javorcik, B. (2020). *COVID-19 and Trade Policy*. CEPR Press.

Jena, J., Sidharth, S., Thakur, L. S., Pathak, D. K., & Pandey, C. V. (2017). Total Interpretive Structural Modeling (TISM): approach and application. *Journal of Advances in Management Research*.

Kamble, S. S., Gunasekaran, A., & Raut, R. D. (2018). Analysing the implementation barriers of dual cycling in port container terminal using interpretive structural modeling-Indian context. *International Journal of Logistics Research and Applications*.

Karpman, M., Zuckerman, S., & Peterson, G. (2020, July). *Adults in Families Losing Jobs during the Pandemic Also Lost Employer Sponsored Health Insurance.* Retrieved from Urban Institute: https://www.urban.org/sites/default/files/publication/102533/adults-in-families-losing-jobs-in-the-pandemic-also-lost-employer-sponso_1.pdf

KoshleH.KaurR.BasistaR. (2020). Breakdown of business and workers in India: Impact of coronavirus. SSRN. 10.2139/ssrn.3557544

Kumar, S., Raut, R. D., Narwane, V. S., & Narkhede, B. E. (2020). *Applications of industry 4.0 to overcome the COVID-19 operational challenges*. Elsevier.

Kumar, R., Agrawal, R., & Sharma, V. (2013). e-Applications in Indian agri-food supply chain: Relationship among enablers. *Global Business Review*, *14*(4), 711–727. doi:10.1177/0972150913501610

Kumar, R., Agrawal, R., & Sharma, V. (2014). Barriers to e-Application in agrifood supply chain. In J. Wang (Ed.), *Encyclopedia of Business Analytics and Optimization* (pp. 235–248). IGI Global., doi:10.4018/978-1-4666-5202-6.ch022

Kumar, R., Agrawal, R., & Sharma, V. (2015). IT Enablement in sugar supply chain: An approach for farmers. *International Journal of Business Performance and Supply Chain Modelling*, *7*(4), 360–381. doi:10.1504/IJBPSCM.2015.073770

McCarthy, B. J. (2016). An overview of the technical textiles sector. In *Handbook of Technical Textiles*. Woodhead Publishing. doi:10.1016/B978-1-78242-458-1.00001-7

McCarthy, B. J. (2016). *Handbook of Technical Textiles*. Elsevier Ltd.

Ministry of textiles, Govt. of India. (n.d.). Retrieved from Ministry of Textiles: http://texmin.nic.in/textile-data

Mor, R. S., Bhardwaj, A., & Singh, S. (2018). Benchmarking the interactions among performance indicators in dairy supply chain: An ISM approach. *Benchmarking*, *25*(9), 3858–3881. doi:10.1108/BIJ-09-2017-0254

Mohseni, M., Abdollahi, A., & Siadat, S. H. (2019). Sustainable Supply Chain Management Practices in Petrochemical Industry Using Interpretive Structural Modeling. *International Journal of Information Systems and Supply Chain Management*, *12*(1), 22–50. doi:10.4018/IJISSCM.2019010102

Mukherjee, S., & Chanda, R. (2016). Impact of Trade Liberalization on Indian Textile Firms: A Panel Analysis. In *International Trade and International Finance* (pp. 229–225). Springer. doi:10.1007/978-81-322-2797-7_11

Naeem, M. (2021). Uncovering and Addressing the Challenges in the Adoption of E-Procurement System: Adoption Process Stages in SMEs. *International Journal of Information Systems and Supply Chain Management*, *14*(1), 1–22. doi:10.4018/IJISSCM.2021010101

O'Leary, D. E. (2020). Evolving Information Systems and Technology Research Issues for COVID-19 and Other Pandemics. *Journal of Organizational Computing*, *30*(1), 1–8. doi:10.1080/10919392.2020.1755790

O'Neil, S. (2020, March 20). *How the World Will Look After the Coronavirus Pandemic*. Retrieved from foreignpolicy.com: https://foreignpolicy.com/2020/03/20/world-order-after-coroanvirus-pandemic/

Paul, R. (2019). *High Performance Technical Textiles*. John Wiley & Sons Ltd. doi:10.1002/9781119325062

Raut, R., Priyadarshinee, P., Jha, M., Gardas, B. B., & Kamble, S. (2018). Modeling the implementation barriers of cloud computing adoption: An interpretive structural modeling. *Benchmarking*, *25*(8), 2760–2782. doi:10.1108/BIJ-12-2016-0189

Reardon, T., Mishra, A., Nuthalapati, C., Bellamare, M. F., & Zilberman, D. (2020). COVID-19's Disruption of India's Transformed Food Supply Chains. *Economic and Political Weekly, 55*(18).

Rio-Chanona, R. D., Mealy, P., Pichler, A., Lafond, F., & Farmer, J. (2020). *Supply and demand shocks in the COVID-19 pandemic: An industry and occupation perspective.* arXiv:2004.06759 [econ.GN].

Roggeveen, A., & Sethuraman, R. (2020). How the COVID Pandemic May Change the World of Retailing. *Journal of Retailing*, *xxx*(2), 2020. doi:10.1016/j.jretai.2020.04.002

Sarkis, J., Cohen, M., Dewick, P., & Schröder, P. (2020, August). A brave new world: Lessons from the COVID-19 pandemic for transitioning to sustainable supply and production. *Resources, Conservation and Recycling*, *159*, 104894. doi:10.1016/j.resconrec.2020.104894 PMID:32313383

Sheth, J. (2020). Impact of Covid-19 on consumer behavior: Will the old habits return or die? *Journal of Business Research*, *117*, 280–283. doi:10.1016/j.jbusres.2020.05.059 PMID:32536735

Shibin, K. T., Dubey, R., & Gunasekaran, A. (2017). *Explaining Sustainable Supply Chain Performance Using a Total Interpretive Structural Modeling Approach.* researchgate.net.

Solanki, D. (2017). A role of textile industry in Indian economy. *National Journal of Advanced Research, 3*(3), 60-65.

Sushil. (2017). Modified ISM/TISM Process with Simultaneous Transitivity Checks for Reducing Direct Pair Comparisons. *Global Journal of Flexible Systems Management*.

Vanchan, V., Mulhall, R., & Bryson, J. (2017). Repatriation or Reshoring of Manufacturing to the U.S. and UK: Dynamics and Global Production Networks or from Here to There and Back Again. *Growth and Change*.

Verma, S. (2002). Export competitiveness of Indian textile and garment industry. *Indian Council for Research on International Economic Relations*.

Zhao, B., Jiang, X., & Cao, J. (2020). *Analysis on the COVID-19 Protective Clothing*. Scientize Publishers.

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